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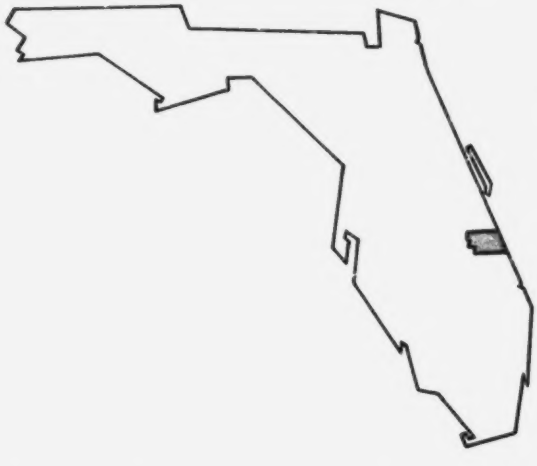
FLOOD INSURANCE STUDY

WAVE HEIGHT ANALYSIS



INDIAN RIVER COUNTY, FLORIDA
UNINCORPORATED AREAS

JUNE 1, 1982

Federal Emergency Management Agency

COMMUNITY NUMBER-120119

ANALYSIS OF WAVE HEIGHTS
FOR
INDIAN RIVER COUNTY, FLORIDA

FEDERAL EMERGENCY MANAGEMENT AGENCY

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1.0 INTRODUCTION

1.1 Background and Purpose

The Federal Emergency Management Agency recently adopted recommendations by the National Academy of Sciences to include prediction of wave heights in Flood Insurance Studies for coastal communities subject to storm surge flooding, and to report the estimated wave crest elevations as the base flood elevations on Flood Insurance Rate Maps (FIRMs).

Previously, FIRMs were produced showing only the stillwater storm-surge elevations due to the lack of a suitable and generally applicable methodology for estimating the wave crest elevations associated with storm surges. These stillwater elevations were subsequently stipulated in community flood plain management ordinances as the minimum elevation of the first floor of new construction. Communities and individuals had to consider the additional hazards of velocity waters and wave action on an ad hoc basis. Because there has been a pronounced tendency for buildings to be constructed only to meet minimum standards, without consideration of the additional hazard due to wave height, increasing numbers of people could unknowingly be accepting a high degree of flood-related personal and property risk in coastal areas subject to wave action. Therefore, the Federal Emergency Management Agency has pursued the development of a suitable methodology for estimating the wave crest elevations associated with storm surges. The recent development of such a methodology by the National Academy of Sciences (Reference 1) has led to the adoption of wave crest elevations for use as the base flood elevations in coastal communities.

Indian River County is located on the open coast and subject to flooding from tidal surges associated with hurricanes.

Flooding has been caused by several hurricanes in and around Indian River County. Among the more severe were the storms of July-August 1926, August 1928, September 1928, and August-September 1964. The hurricane of September 1928 is considered one of the most violent ever to strike Florida. High water and wave damage were reported along the entire length of Indian River. The center of Hurricane Cleo (August-September 1964) passed through Indian River County in a north-northwesterly direction almost parallel to the Florida coast.

The purpose of this study is to revise the FIRM for the unincorporated areas of Indian River County to include the effects of wave action associated with flooding from the Atlantic Ocean at the open coast and at Indian River and Sebastian Creek.

2.0 INVESTIGATIONS

2.1 Previous Studies

Stillwater elevations for hurricane surges with 10-, 50-, 100-, and 500-year return periods were determined by the National Oceanic and Atmospheric Admini-

stration (NOAA) for the open coast of Indian River County. The 100-year stillwater elevations were used as base flood elevations for the Flood Insurance Study and the FIRM that have been prepared for Indian River County (References 2 and 3).

The NOAA storm-surge elevations were determined using a computer model of hurricane forces (References 4 and 5). Weather records were analyzed to determine probable atmospheric pressure drop, radius of maximum winds, and forward speed and direction of storms occurring near the study area. Using these data in conjunction with the astronomical tides and bathymetric data, stillwater elevations for various probabilities were calculated. Results of these calculations wre calibrated against tide gage records and high-water marks for historical events at various locations along the coast.

Tidal backwater elevations for Indian River and Sebastian Creek were originally determined by NOAA using the above data in conjunction with subjective judgment regarding terrain and depth. The 100-year stillwater elevations were used as base flood elevations for the FIRM that is currently in effect.

Storm-surge elevations for the open coast and for Indian River north of East Causeway Boulevard in Vero Beach used in this analysis are the same as those determined by NOAA for the FIRM currently in effect for Indian River County (Reference 2).

Storm-surge elevations for Indian River south of East Causeway Boulevard and for Sebastian Creek were adjusted based on an analysis of local physiography in relation to storm-tide flow and surge determinations for the adjacent Brevard and St. Lucie Counties.

The stillwater elevations developed for these previous studies were used as the starting elevations for the wave height analysis presented herein.

This report is authoritative for the purposes of the National Flood Insurance Program, and data presented herein supersede all previous flood elevation determinations.

2.2 Data Collection and Review

All available source data applicable for the wave height analysis were collected and reviewed. Because wave height calculations are based on such parameters as the size and density of vegetation, natural barriers (sand dunes), buildings, and other manmade structures, it was necessary to obtain detailed information on the physical and cultural features of the study area.

Officials of Indian River County and its incorporated coastal communities were contacted for maps and other possible data sources to be used in the analysis. In addition, the Florida Department of Natural Resources, Bureau of Beaches and Shores; the Florida Department of Transportation; the U.S. Army Corps of Engineers, Jacksonville District; and the National Ocean Survey were contacted and all applicable data sources were obtained.

The principal source materials used for the wave height analysis are listed below.

a. Topographic data (ground elevations, seawall elevations, and locations of physical features) were determined using U.S. Geological Survey topographic maps at a scale of 1:24,000, with a contour interval of 5 feet (Reference 6); National Ocean Survey storm evacuation maps at a scale of 1:62,500, with a contour interval of 5 feet (Reference 7); Florida Department of Natural Resources beach profiles of the immediate Atlantic coast (Reference 8); topographic maps at a scale of 1:1,200, with a contour interval of 2 feet, obtained from the Florida Department of Natural Resources (Reference 9); and City of Vero Beach topographic maps at a scale of 1:1,200 with a contour interval of 1 foot for several portions of Indian River County adjacent to Vero Beach (Reference 10).

b. Recent stereoscopic aerial photography at a scale of 1:12,000, was used to determine vegetation and building parameters and to supplement the topographic maps for locations of physical features (References 11 and 12).

2.3 Wave Height Analysis

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in the National Academy of Sciences report (Reference 1). This method is based on the following major concepts. First, depth-limited waves in shallow water reach a maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions, such as sand dunes, dikes and seawalls, buildings, and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures prescribed in Reference 1. The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

Wave heights were computed along transects (cross section lines) in accordance with the Users Manual for Wave Height Analysis (Reference 13). The transects were located along the coastline as shown in Figure 1. They were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, they were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects.

Each transect was taken perpendicular to the shoreline and extended to the inland limit of tidal flooding. Along each transect, wave heights and elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. The stillwater elevations for the 100-year flood were used as the starting elevations for these computations. Wave heights were calculated to the nearest 0.1 foot, and wave elevations were determined at whole-foot increments along the transects. The location of

Palm Bay
Malabar
Valkaria
Valkaria
Valkaria Missile Tracking Station (USAF)
FLORIDA EAST COAST
Evans Pines
Grant
Floridana Beach
Ballard Pines
ATLANTIC
Micco
PELICAN ISLAND NWR
Numerous
BREVARD CO
INDIAN RIVER CO
Roseland
Sebastian
Sebastian Tower
Cummings
Small
Ponds
Pelican Island Wilderness
Fellsmere
Tower
River Bridge
Vero Lake Estates
Wabasso
Fellsmere Missile Tracking Station (USAF)
Sugar mill
Substation
Winter Beach
Brocke
Johns Island
Indian River Shores
OCEAN
Gifford
Vero Beach Tracking Annex (USAF)
Vero Beach
Light
Vero Beach
Paradise Park
Riomar
Prong Island
McKee Jungle Gardens
Hibiscus
Tower
Vero Beach Highlands

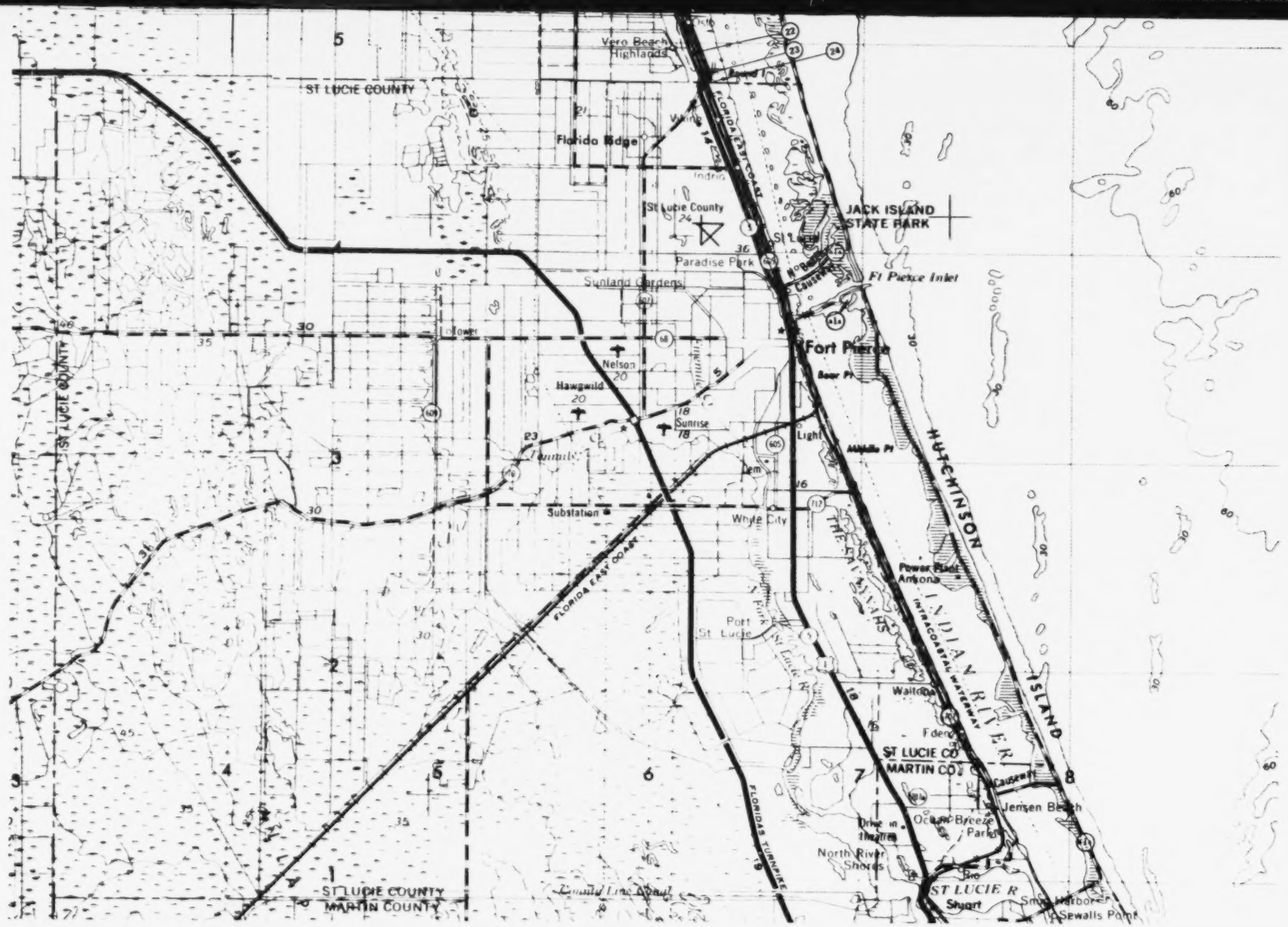

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

INDIAN RIVER COUNTY, FL

APPROXIMATE SCALE

2000 0 2000 4000 6000 FEET

TRANSECT LOCATION MAP

4a

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the 3-foot breaking wave for determining the terminus of the V Zone (area with velocity wave action) was also computed at each transect. Table 1 provides a listing of the transect locations and stillwater elevations, as well as maximum wave crest elevations in Indian River County.

Wave diffraction caused by the headlands of St. Augustine Inlet was analyzed based on concepts and procedures presented in the Shore Protection Manual (Reference 14) and engineering judgment.

Figure 2 is a profile for a typical transect illustrating the effects of energy dissipation and regeneration on a wave as it moves inland. This figure shows the wave elevations being decreased by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Actual wave conditions in Indian River County may not necessarily include all the situations illustrated in Figure 2.

After analyzing wave heights along each transect, wave elevations were interpolated between transects. Various source data were used in the interpolation, including topographic maps (References 6, 7, 9, and 10), beach profiles (Reference 8), and aerial photographs (References 11 and 12), along with engineering judgment. Controlling features affecting the elevations were identified and considered in relation to their positions at a particular transect and their variation between transects.

2.4 Results

Wave heights of approximately 6 feet, with wave crest elevations of 12 feet, will be encountered at the Atlantic Ocean open coast shoreline during a 100-year storm tide. These waves are completely dissipated, and the 100-year storm surge is stopped at the seaward toe of the primary coastal dune by rising ground elevations. No shore protection structures are located within the 100-year Atlantic coastal flood plain in Indian River County.

North of Pauls Island on Indian River, wave heights of approximately 3.5 feet with wave crest elevations of 10 to 11 feet are generated across the wide fetches of Indian River. On Indian River south of Pauls Island, narrower fetches and lower stillwater elevations reduce the calculated wave heights and associated wave crest elevations. From Pauls Island to Wabasso Bridge (State Highway 510), wave heights of approximately 2.5 feet, with wave crest elevations of 9 feet, are generated across Indian River. From Wabasso Bridge to Johns Island (in Indian River Shores), wave heights of approximately 2 feet, with wave crest elevations of 7 feet, are generated. From south of Johns Island to East Causeway Boulevard (in Vero Beach), wave heights of 1 to 2 feet with wave crest elevations of 6 feet, are generated. South of East Causeway Boulevard, wider fetches enable wave heights of approximately 2.5 feet, with wave crest elevations of 8 feet, to be generated across Indian River. These waves are dissipated primarily on the western shore of Indian River by a combination of rising ground elevations and obstructions in the flood plain such as buildings and vegetation. In some cases, islands in Indian River with sufficient ground elevation and obstruction characteristics can dissipate wave energy. Areas along the western shore of Indian River which

Table 1.
Transect Locations, Stillwater Elevations, and Maximum Wave Crest Elevations

Transect	Location	Elevation (Feet NGVD) Stillwater	Wave Crest
1	Brevard County/Indian River County - From the Atlantic coastline westward across Indian River and Sebastian Creek to the limit of inundation by the 100-year storm surge; crosses U.S. Highway 1 approximately 1000 feet south of Sebastian Creek	8.0[1]	11[1]
2	Brevard County/Indian River County - From Sebastian Inlet westward across Indian River to the limit of inundation by the 100-year storm surge, approximately 475 feet north of intersection of Roseland Road and North Indian River Drive in Indian River County	8.0[1]	11[1]
3	Indian River County - From the Atlantic coastline westward across Indian River to the limit of inundation by the 100-year storm surge; crosses State Highway A1A approximately 1600 feet south of Sebastian Inlet	8.0[2]	12[2]
4	Indian River County - From the Atlantic coastline westward across Indian River to the limit of inundation by the 100-year storm surge; crosses North Indian River Drive approximately 300 feet south of intersection with Land Circle	8.0[2]	12[2]
5	Indian River County/Sebastian - From the Atlantic coastline westward across Indian River to the limit of inundation by the 100-year storm surge; crosses Riverside Avenue approximately 175 feet north of intersection with Cleveland Street in Sebastian	8.0[2]	12[2]
6	Indian River County/Sebastian - from the east side of Indian River westward to the limit of inundation by the 100-year storm surge; crosses Riverside Avenue in Indian River County approximately 800 feet south of intersection with Harrison Street (in Sebastian)	8.0[1]	10[1]

[1] Indian River
[2] Atlantic Ocean

Table 1. (Cont'd)
Transect Locations, Stillwater Elevations, and Maximum Wave Crest Elevations

Transect	Location	Elevation (Feet NGVD) Stillwater	Wave Crest
7	Indian River County - From the east side of Indian River westward to the limit of inundation by the 100-year storm surge; crosses State Highway A1A approximately 1750 feet north of intersection with Jungle Trail	8.0[1]	10[1]
8	Indian River County - From the east side of Indian River westward to the limit of inundation by the 100-year storm surge approximately 600 feet north of intersection of U.S. Highway 1 and Schumann Drive (in Sebastian)	8.0[1]	10[1]
9	Indian River County - From the Atlantic coastline westward across Indian River through Roosevelt and Pauls Islands to the limit of inundation by the 100-year storm surge	8.0[2]	12[2]
10	Indian River County - From the east side of Indian River westward through North Horseshoe, Horseshoe, and Middle Islands to the limit of inundation by the 100-year storm surge	7.0[1]	9[1]
11	Indian River County/Orchid - From the Atlantic coastline westward across Indian River to the limit of inundation by the 100-year storm surge, approximately 300 feet east of U.S. Highway 1 and 2500 feet north of Wabasso	8.0[2]	12[2]
12	Indian River County/Orchid - From the east side of Indian River westward across Indian River through the northern portion of Wabasso Island to the limit of inundation by the 100-year storm surge; crosses 44th Avenue approximately 1900 feet north of intersection with Wabasso Bridge Road	7.0[1]	9[1]

[1]Indian River
[2]Atlantic Ocean

Table 1. (Cont'd)
Transect Locations, Stillwater Elevations, and Maximum Wave Crest Elevations

Transect	Location	Elevation (Feet NGVD) Stillwater	Wave Crest
13	Indian River County - From the east side of Indian River westward to the limit of inundation by the 100-year storm surge; crosses the east end of Martha Lane	6.0[1]	7[1]
14	Indian River Shores/Indian River County - From the Atlantic coastline westward across Indian River to the limit of inundation by the 100-year storm surge; crosses Luther Road at intersection with road to Copelands Landing in Indian River County	6.0[1]	7[1]
15	Indian River Shores/Indian River County - From the Atlantic coastline westward across Indian River to the limit of inundation by the 100-year storm surge; crosses State Highway A1A approximately 1600 feet south of intersection with Johns Island Drive in Indian River Shores	6.0[1]	7[1]
16	Indian River Shores/Indian River County - From the Atlantic coastline westward across Indian River, through Gifford Island to the limit of inundation by the 100-year storm surge; crosses State Highway A1A in Indian River Shores, approximately 2700 feet south of intersection with Fred R. Tuerk Road	5.0[1]	6[1]
17	Vero Beach/Indian River County - From the Atlantic coastline westward across Indian River to the limit of inundation by the 100-year storm surge; crosses Bethel Creek Drive in Vero Beach approximately 250 feet south of intersection with El Perdido Street	5.0[1]	6[1]
18	Vero Beach - From the east side of Indian River westward to the limit of inundation by the 100-year storm surge; crosses east end of Sailfish Road	5.0[1]	6[1]

[1]Indian River

Table 1. (Cont'd)
Transect Locations, Stillwater Elevations, and Maximum Wave Crest Elevations

Transect	Location	Elevation (Feet NGVD) Stillwater	Wave Crest
19	Vero Beach - From the Atlantic coastline westward across Indian River to the limit of inundation by the 100-year storm surge; crosses south edge of River Drive cul-de-sac	8.0[2]	12[2]
20	Vero Beach/Indian River County - From the Atlantic coastline westward across Indian River to the limit of inundation by the 100-year storm surge; crosses State Highway A1A approximately 800 feet north of intersection with East Causeway Boulevard	6.0[1]	6[1]
21	Indian River County - From the east side of Indian River westward to the limit of inundation by the 100-year storm surge; between Pine Arbor Lane and Forest Park Drive	6.0[1]	8[1]
22	Indian River County - From the east side of Indian River westward to the limit of inundation by the 100-year storm surge; approximately 400 feet east of U.S. Highway 1 and 2900 feet north of intersection with SE 21st Street	6.0[1]	8[1]
23	Indian River County - From the east side of Indian River westward to the limit of inundation by the 100-year storm surge; crosses 6th Avenue approximately 625 feet north of intersection with SE 23rd Street	6.0[1]	8[1]
24	Indian River County - From the Atlantic coastline westward across Indian River to the limit of inundation by the 100-year storm surge; crosses western shoreline of Indian River approximately 350 feet south of SE 23rd Street	8.0[2]	12[2]

[1]Indian River
[2]Atlantic Ocean

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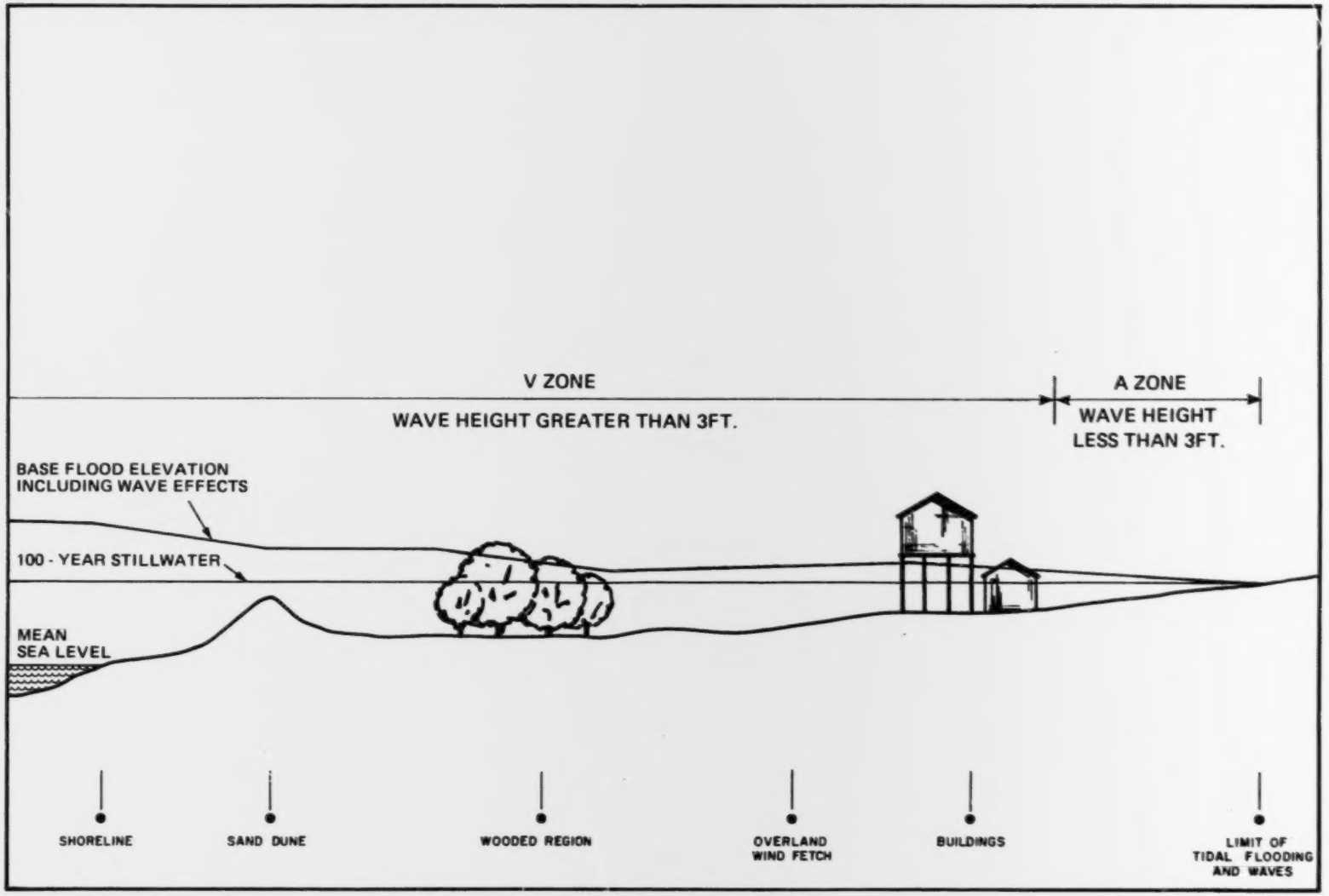

FIGURE 2
TYPICAL TRANSECT SCHEMATIC

have been bulkheaded are provided protection from waves by depth-limitation when the bulkheads are built to sufficient elevations. These structures are expected to remain intact during a 100-year storm tide.

Wave heights of approximately 4 feet, with wave crest elevations of 10 feet, will propagate into Sebastian Creek from Indian River. These waves are quickly dissipated by the effects of drag from the shorelines.

From just inside the mouth of Sebastian Creek, upstream of the wave effects from Indian River, to the confluence of North and South Prongs of Sebastian Creek, wave heights of approximately 1 foot are generated. Upstream of the Florida East Coast Railroad bridge, wave crest elevations reach 7 feet; downstream of the bridge, a higher surge elevation produces wave crest elevations of up to 8 feet. These waves are dissipated along the western side of Sebastian Creek, outside Indian River County.

3.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage local governments to adopt sound flood plain management programs designed to reduce future flood losses. The FIRM for Indian River County has been revised to incorporate the latest available information, including wave height data, to assist the county in developing the most appropriate and effective flood plain management measures.

3.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Emergency Management Agency as the base flood for purposes of flood plain management. This flood has a 1 percent chance of being equalled or exceeded each year and is expected to be exceeded once on the average during any 100-year period. The risk of having a flood of this magnitude or greater increases when periods longer than 1 year are considered. For example, over a 30-year period, there is a 26 percent chance of experiencing a flood equal to or greater than the 100-year flood. The 500-year flood plain is also shown on the FIRM to indicate areas of moderate flood hazards.

Areas inundated by the 100-year flood are shown as A and V Zones on the community's FIRM. It is in these areas that the Federal Emergency Management Agency requires local communities to exercise flood plain management measures as a condition for participation in the National Flood Insurance Program.

3.2 Base Flood Elevations

Areas within the county studied by detailed engineering methods have base flood elevations established in A and V Zones. These are the elevations of the base (100-year) flood relative to the National Geodetic Vertical Datum of 1929. In coastal areas affected by wave action, base flood elevations are generally maximum at the open coast shoreline. These elevations generally

decrease in a landward direction at a rate dependent on the presence of obstructions capable of dissipating the wave energy. Where possible, changes in base flood elevations have been shown in 1-foot increments on the FIRMs. However, where the scale did not permit, 2- or 3-foot increments were sometimes used. Base flood elevations shown in the wave action areas represent the average elevation within the zone. Current program regulations generally require that all new construction be elevated such that the first floor, including basement, is above the base flood elevation in A and V Zones.

3.3 Velocity Zones

The U.S. Army Corps of Engineers (Reference 15) has established the 3-foot breaking wave as the criterion for identifying coastal high hazard zones. This was based on a study of wave action effects on structures. This criterion has been adopted by the Federal Emergency Management Agency for the determination of V Zones. Because of the additional hazards associated with high-energy waves, the National Flood Insurance Program regulations require much more stringent flood plain management measures in these areas, such as elevating structures on piles or piers. In addition, insurance rates in V Zones are higher than those in A Zones with similar numerical designations.

The location of the V Zone is determined by the 3-foot breaking wave as discussed previously. The detailed analysis of wave heights performed in this study allowed a much more accurate location of the V Zone to be established. The V Zone generally extends inland to the point where the 100-year flood depth is insufficient to support a 3-foot breaking wave.

4.0 INSURANCE APPLICATION

The assignment of proper actuarial insurance rates requires that frequency and depth of flooding be estimated as accurately as possible. Because waves can add considerably to expected flood depths, it is important that insurance rates consider this additional hazard. The Federal Emergency Management Agency has developed a process to transform the data from this study into flood insurance criteria. This process includes the determination of Flood Hazard Factors and the designation of flood insurance zones.

4.1 Flood Hazard Factors

The Flood Hazard Factor (FHF) is the device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHF are used to set actuarial insurance premium rate tables.

The FHF is shown as a three-digit code that expresses the difference between the 10- and 100-year flood elevations to the nearest 0.5 foot. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, the FHF is computed to the nearest foot.

4.2 Flood Insurance Zones

After wave elevations for the 100-year storm surge were determined and mapped, the study areas were divided into zones, each having a specific flood potential and FHF. Each zone was assigned one of the following flood insurance zone designations:

Zones V11 and V12:	Special Flood Hazard Areas inundated by the 100-year flood, and that have additional hazards due to velocity (wave action); base flood elevations shown, and zones subdivided according to FHFs.
Zones A7, A8, A9, A10, and A12:	Special Flood Hazard Areas inundated by the 100-year flood, with base flood elevations determined and zone designations assigned according to the FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood plain, including areas that are protected from the 100- and 500-year floods by dike, levee, or other water control structure; and areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot, or where the contributing drainage area is less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas not subject to flooding by the 500-year flood. Zone C is not subdivided.

Table 2, "Flood Insurance Zone Data," summarizes the FHFs, flood insurance zones, and base flood elevations for each flooding source in the study area.

4.3 Flood Insurance Rate Map

After flood insurance zones were established for the study area, the FIRM for Indian River County was revised to incorporate the new zone information. This map (Exhibit 1) contains the official delineation of flood insurance zones and base flood elevations.

In preparing the revised FIRM, updated topographic information was used to revise the Atlantic coastline and some zone boundaries in areas not affected by the wave height analysis. Corporate limits and cultural features were revised using current county and community maps (References 16, 17, and 18).

Table 2. Flood Insurance Zone Data

Flooding Source	Stillwater Elevation 10-Year	50-Year	100-Year	500-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
Atlantic Ocean							
Open Coast	4.2	6.8	8.0	10.4	060	V12	10 to 12
					050	A10	8 to 10
Indian River							
North of Pauls Island	4.2	6.8	8.0	10.4	060	V12	10,11
					060	A12	10
					050	A10	8 to 10
					045	A9	8 to 10
Pauls Island to State Highway 510	3.2	5.8	7.0	9.4	060	V12	9
					045	A9	7 to 9
State Highway 510 to Johns Island	2.2	4.8	6.0	8.4	045	A9	6,7
Johns Island to East Causeway Boulevard	1.2	3.8	5.0	7.4	045	A9	5,6
South of East Causeway Boulevard	2.2	4.8	6.0	8.4	050	A10	6 to 8
Sebastian Creek							
Downstream of Florida East Coast Railroad	3.3	5.8	7.0	9.4	055	V11	9,10
					045	A9	7 to 9
Upstream of Florida East Coast Railroad	2.3	4.8	6.0	8.4	045	A9	6,7
South Prong	2.3	4.8	6.0	8.4	035	A7	6
	2.2	4.8	6.0	8.4	040	A8	6
	1.2	3.8	5.0	7.4	040	A8	5

*Due to map scale limitations, base flood elevations shown on the FIRM may represent average elevations for the zones depicted.

5.0 OTHER STUDIES

Revised Flood Insurance Studies for the incorporated communities of Indian River Shores and Vero Beach, and the adjacent St. Lucie and Brevard Counties are being prepared concurrently with Indian River County to include wave height analysis. The revised studies for these communities, with the exception of Brevard County, will be in agreement with this study. The 10-year stillwater elevation used for Brevard County differs slightly from that used for Indian River County, creating different zone designations.

The Flood Insurance Studies for the incorporated communities of Orchid and Sebastian are not being revised at this time to include wave height analysis and, therefore, will not be in agreement with this study.

6.0 REFERENCES

1. National Academy of Sciences, Methodology for Calculating Wave Action Effects Associated with Storm Surges, 1977

2. Federal Emergency Management Agency, Flood Insurance Rate Map, Indian River County, Florida (Unincorporated Areas), Scale 1:24,000, January 23, 1981

3. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Indian River County, Florida, January 1978

4. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Technical Memorandum NWS TDL 52, SPLASH (Special Program to List Amplitudes of Surges from Hurricanes): Part I, Landfall Storms, C.P. Jelesnianski, 1972

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6. U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 5 feet: Sebastian, Florida (1949), Photorevised (1970); Vero Beach, Florida (1949), Photorevised (1970); Riomar, Florida (1948), Photorevised (1970); Oslo, Florida (1949), Photorevised (1970); Indrio, Florida (1948), Photorevised (1970); Fellsmere, Florida (1949), Photorevised (1970)

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